

PTO 10-0408

CC=JP  
DATE=19980529  
KIND=A  
PN=10144333

A FUEL CELL SYSTEM  
[NENRYO DENCHI SHISUTEMU]

NOBORU HONDA, ET AL.

UNITED STATES PATENT AND TRADEMARK OFFICE  
WASHINGTON, D.C.                      OCTOBER 2009  
TRANSLATED BY: SCHREIBER TRANSLATIONS, INC.

PUBLICATION COUNTRY	(10):	JP
DOCUMENT NUMBER	(11):	10144333
DOCUMENT KIND	(12):	Kokai
PUBLICATION DATE	(43):	19980529
APPLICATION NUMBER	(21):	08303277
APPLICATION DATE	(22):	19961114
INTERNATIONAL CLASSIFICATION	(51):	H 01 M 8/04, F 25 B 17/08
PRIORITY COUNTRY	(33):	
PRIORITY NUMBER	(31):	
PRIORITY DATE	(32):	
INVENTOR(S)	(72):	Noboru Honda et al.
APPLICANT(S)	(71):	DENSO Corporation
DESIGNATED CONTRACTING STATES	(81):	
TITLE	(54):	A FUEL CELL SYSTEM
FOREIGN TITLE	[54A]:	Nenryo Denchi Shisutemu

[Scope of patent claims]

[Claim 1] A fuel cell system having a fuel cell (2), which generates power through the reaction of a fuel and an oxidant, and an absorption device (5), which absorbs an absorptive medium in a cooling state and has a plurality of absorbents (52) that desorb the absorptive medium in a heating state, that is characterized by the fact that right after the above mentioned fuel cell (2) begins generating power, the above mentioned absorbents (52) of the above mentioned absorption device (5) absorb the above mentioned absorptive medium and the above mentioned fuel cell (2) is heated with the absorption heat from this absorption.

[Claim 2] The fuel cell system set forth in claim 1 wherein the above mentioned absorptive medium is desorbed from the above mentioned absorbents (52) by heating the above mentioned absorption device (5) with the heat generated by the above mentioned fuel cell (2) when the above mentioned fuel cell (2) is in a steady state of power generation.

[Claim 3] The fuel cell system set forth in claim 2 wherein a condensation and evaporation device (6), which

---

<sup>1</sup> Numbers in the margin indicate pagination in the foreign text.

has the above mentioned absorptive medium built-in, evaporates the above mentioned absorptive medium when the above mentioned absorption device (5) absorbs the above mentioned absorptive medium, and condenses the above mentioned absorptive medium when the above mentioned absorption device (5) desorbs the above mentioned absorptive medium, is placed in communication with the above mentioned absorptive device (5), and an opening and closing means (43) is placed on the connecting part (55) of the above mentioned absorption device (5) and the above mentioned condensation and evaporation device (6) to open and close this connecting part (55), which is characterized by the fact that right after the above mentioned fuel cell (2) begins generating power, the above mentioned connecting part (55) is opened with the above mentioned opening and closing means (43) and after the above mentioned absorptive medium is desorbed from the above mentioned absorbents (52), the above mentioned connecting part (55) is closed with the above mentioned opening and closing means (43).

[Claim 4] The fuel cell system set forth in claim 2 or 3 wherein a cooling device (8) cools the above mentioned fuel cell by taking away the above mentioned heat from the above mentioned fuel cell (2), and wherein the above mentioned fuel cell (2) is cooled by using the above

mentioned heat of the above mentioned fuel cell (2) to heat the above mentioned absorption device (5) when the above mentioned absorptive medium is being desorbed from the above mentioned absorbents (52), and the above mentioned fuel cell (2) is cooled with the above mentioned cooling device (8) after the above mentioned absorptive medium is desorbed.

[Claim 5] The fuel cell system set forth in any one of the claims 1 through 4 that is characterized by having: a heat exchange part (25) and a heat exchange part (51) on the above mentioned fuel cell (2) and the above mentioned absorption device (5) that absorbs heat or that releases heat in the fuel cell (2) and the absorption device (5); and a fluid circuit (A) that is connected in series to the above mentioned heat exchange part (25) of the above mentioned fuel cell (2) and the above mentioned heat exchange part (51) of the above mentioned absorption device (5) where the heat exchange fluid flows therein that is characterized by the fact that a pumping means (40) that circulates the heat exchange fluid within the above mentioned fluid circuit (A) is placed on the above mentioned fluid circuit (A).

[Claim 6] The fuel cell system set forth in any one of the claims 3 through 5 that is characterized by having: a

detecting means (45, 46, 200) that detects the absorption and desorption of the above mentioned absorptive medium in the above mentioned absorption device (5); and a controlling means (200) that controls the opening and closing of the above mentioned connecting part (55) with the above mentioned opening and closing means (43) based on the detection signals of the above mentioned detecting means (45, 46, 200).

[Detailed description of the invention]

[0001]

[Technical field] The present invention pertains to a fuel cell system having a fuel cell that generates power through the reaction between a fuel and an oxidant.

[0002]

[Prior art] Usually, right after a fuel cell begins generating power in a fuel cell system, the fuel cell is cryogenic, approximately the temperature of a room. Therefore, the reaction between the fuel and the oxidant does not advance well and sufficient power generation efficiency cannot be obtained. Meanwhile, when the temperature of the fuel cell rises as heat is generated through the continuous generation of power by the fuel cell, the power generation efficiency improves. Further, there is

a possibility that the constituent materials such as the electrodes may be damaged when the temperature of the fuel cell becomes too high.

[0003] Compared to this, a fuel cell system that is equipped with a coolant water circulation circuit that cools the fuel cell and that is further equipped with an electric heater within the this circuit that can heat the coolant water is proposed in Japanese published unexamined patent H7-94202 gazette. Further, the electric power is supplied to the electric heater by the fuel cell or a battery. According to this, right after the fuel cell begins to start up, power is distributed to the electric heater in order to heat the coolant water and the fuel cell can be warmed up with this heated coolant water.

[0004]

[Problems to be solved by the invention] However, the abovementioned conventional technology had a problem that extra electric power that will be supplied to the electric heater was needed whether this electric power was supplied to the electric heater from the fuel cell or whether this electric power was supplied to the electric heater from a battery. The present invention was created in view of the abovementioned problem and its aim is to warm up the fuel cell without using an electric heater.

[0005]

[Means for solving the problem] In order to achieve the abovementioned aim, emphasis was given to the fact that when the absorbents (52) absorb the absorptive medium, absorption heat was released through this absorption. The invention set forth in claim 1 to 6 is characterized by the fact that right after the fuel cell (2) begins generating power, the fuel cell (2) becomes heated by the absorption heat in the absorption device (5) that has a plurality of absorbents (52).

[0006] With such composition, the fuel cell (2) can be warmed up right after the fuel cell (2) begins generating power by using the absorption heat through the abovementioned absorption without using an electric heater. Thus, the amount of power not used for the electric heater can be saved and the electrical power

/3

of the fuel cell (2) can be effectively used for its initial purpose. Further, in the invention set forth in claim 2, when the fuel cell (2) is in a steady state of power generation, the heat generated by the fuel cell (2) heats the absorption device (5) and the absorptive medium is desorbed from the absorbents (52) of the absorption device (5). In order to warm up the fuel cell (2) right

after the next power generation begins, it is necessary to have the absorptive medium desorbed from the absorbents (52). However, since this desorption can be done by using the heat generated by the fuel cell (2), the electrical power use at this time can be minimized.

[0007] Further, as the fuel cell (2) releases the heat that it generates to the absorption device (5), the fuel cell (2) is prevented from becoming abnormally hot and damage to the fuel cell (2) can be controlled. Further, in the invention set forth in claim 3, after the absorptive medium is desorbed from the absorbents (52), the opening and closing means (43) closes the connecting part (55) of the absorption device (5) and condensation and evaporation device (6). Therefore, until the time the next power generation begins, the desorption state of the absorbents (52) of the absorption device (5) can be maintained as is. Thus, by opening the connecting part (55) when the next power generation begins, a good absorption of the absorptive medium in the absorption device (5) can be conducted and the rapid warm-up of the fuel cell (2) can be done well.

[0008] Further, in the invention set forth in claim 4, the fuel cell (2) is cooled by using the heat of the fuel cell (2) for heating the absorption device (5) when the

absorptive medium is being desorbed from the absorbents (52) and the fuel cell (2) is cooled by the cooling device (8) after the absorptive medium is desorbed. As a result, the fuel cell (2) is prevented from becoming abnormally hot and damage to the fuel cell (2) can be controlled even after the absorptive medium is desorbed.

[0009]

[Embodiments of the invention] The embodiments of the present invention shown in the figures will be described below.

(The first embodiment) Fig. 1 shows a fuel-cell-powered vehicle powered by the fuel cell system 1 of the present invention. The fuel cell system 1 has a fuel cell 2 that generates power through the reaction between a fuel (hydrogen) and an oxidant (oxygen in the air), a fuel tank 3 that stores the fuel, a fuel pump 4 that feeds hydrogen within the fuel tank 3 to the fuel cell 2, an absorption device 5 for rapidly warming up the fuel cell 2, and a condensation and evaporation device 6 that is in communication with the absorption device 5. All of these are placed on the underfloor (outside) of the vehicle. Then, the electrical power from the fuel cell 2 is supplied to the motor 7 for driving the vehicle via the inverter or the converter that are not shown in the figure.

[0010] As shown in Fig. 2, the fuel cell 2 is made by laminating [the following components] in [the following] order: grooved connectors 21 made of carbon; positive electrodes (cathodes) 22 made of porous carbon that is added with a platinum medium; electrolytic layers 23 made of a mixture of carbon fluoride and silicon carbide impregnated with phosphoric acid, and negative electrodes (anodes) 24 made of porous carbon that is added with a platinum medium. Of the grooved connectors 21, those on the side facing the positive electrodes 22 have a plurality of grooves 211 formed in the perpendicular direction on the plane of the paper in Fig. 2 and those on the side facing the negative electrodes 24 have a plurality of grooves 212 formed in the horizontal direction on the plane of the paper in Fig. 2.

[0011] Then, air is supplied to the grooves 211 with an air pump that is not shown in the figure, and the hydrogen within the fuel tank 3 is supplied to the grooves 212 via the fuel pump 4. Then, the heat exchange parts 25, where the heat exchange fluid flows, are placed on the grooved connectors 21 on the edges in the lamination direction. The fuel tank 3 is made by housing a heat exchange part 31, where the heat exchange fluid flows, and hydrogen absorbing alloys (fuel absorbing alloys) 32, for

example  $\text{LaNi}_5\text{H}_6$ , that are secured around this heat exchange part 31 within an airtight container 30. The hydrogen absorbing alloys 32 are ones that cool, or that heat through the absorption of hydrogen by increasing the pressure, or that release hydrogen by reducing the pressure. In the present embodiment, hydrogen is released from the hydrogen absorbing alloys 32 by reducing the pressure within the fuel tank 3 with the fuel pump 4. Further, hydrogen is periodically absorbed and stored in the hydrogen absorbing alloys 32 because the hydrogen becomes consumed as the fuel cell 2 is used.

[0012] The absorption device 5 is made by housing a heat exchange part 51, where heat exchange fluid flows, and a plurality of granular absorbents 52 (for example silica gel) that are secured around this heat exchange part 51 within an airtight container 50. The absorbents 52 absorb the absorptive medium (for example water) by being cooled and desorb the absorptive medium thereof by being heated. The condensation and evaporation device 6 is made by housing a heat exchange part 61, where heat exchange fluid flows, and water W as the absorptive medium within an airtight container 60. Further, an opening and closing valve (opening and closing means) 43 that opens and closes the connecting part 55 is placed on the connecting part 55

of the airtight container 60 of the condensation and evaporation device 6 and the airtight container 50 of the absorption device 5.

[0013] Then, the heat exchange part 25 of the fuel cell 2 and the heat exchange part 51 of the absorption device 5 are connected in series with the fluid circuit A and the heat exchange part 25 of the fuel cell 2 and the outdoor heat exchange device (cooling device) 8 are connected in series with the fluid circuit B. Moreover, the heat exchange fluid can circulate to the fluid circuit A and B through the water pump (pumping means) 40 that is placed in the location where the fluid circuit A and B overlap. Further, the heat exchange liquid circulates to the fluid circuit A and B through the three-way selector valves 41 and 42.

[0014] Moreover, the outdoor heat exchange device 9 and the heat exchange part 61 of the condensation and evaporation device 6 are connected in series with the fluid circuit C and the outdoor heat exchange device 9 and the heat exchange part 31 of the fuel tank 3 are connected in series with the fluid circuit D. Moreover, the heat exchange fluid can circulate to the fluid circuit C and D through the water pump (pumping means) 44 that is placed in the location where the fluid circuit C and D overlap.

[0015] Moreover, a thermal sensing devices (detecting means) 45 and 46 that detects the temperature T1 and T2 of the heat exchange fluids that flow through the inlet part and the outlet part are placed on the inlet part and outlet part of the heat exchange part 51 of

/4

the absorption device 5. Here, an electricity control device (controlling means) 200 is placed on the fuel-cell-powered vehicle of the present embodiment. The ON/OFF signal of the starting switch of the fuel-cell-powered vehicle and the detection signals of the thermal sensing devices 45 and 46 are inputted to this electricity control device 200. Based on these inputted signals, the ON/OFF of the power distribution to the fuel pump 4, the water pumps 40 and 44, and the air pump mentioned above and the switching of the turning positions of the three-way selector valves 41 and 42 and the opening and closing valve 43 are controlled. Further, the electricity control device 200 conducts other various electricity controls that are publicly known.

[0016] Moreover, a battery that is not shown in the figures is also installed independent from the fuel cell 2. This battery charges a predetermined amount of electricity while the vehicle is in operation. Next, the operation of

the present invention with the abovementioned configuration will be described. Further, the electricity control device 200 detects the abovementioned temperatures T1 and T2 for every predetermined time (for example every minute) after the starting switch is tuned on as well as determines the steps S1 to S3 shown in Fig. 4.

[0017] First, when the starting switch of the vehicle is turned on, power is distributed to the electricity control device 200 from the abovementioned battery. The thermal sensing devices 45 and 46 begin detecting the temperatures T1 and T2 while the control 1 shown in Fig. 4 is conducted. To be precise, control 1 is the power distribution to the fuel pump 4, the water pumps 40 and 44, and the abovementioned air pump by turning the opening and closing valve 43 so that the connecting part 55 opens as the turning position of the three-way selector valves 41 and 42 becomes the solid line position in Fig. 1.

[0018] Through this, air is supplied to the grooves 211 of the fuel cell 2 while hydrogen is supplied to the grooves 212. That is to say, the fuel cell 2 begins generating power. As a result, the hydrogen ( $H_2$ ) dissociates into hydrogen ions ( $H^+$ ) and electrons ( $e^-$ ) on the surface of the negative electrodes 24 of the fuel cell 2. The hydrogen ions diffuse in the electrolytic layers 23 and moves to the

positive electrodes 22. The electrons move to the positive electrodes 22 by passing through the outer electric circuit (the motor 7 for driving the vehicle). Then, the hydrogen ions and the electrons react with oxygen ( $O_2$ ) in the positive electrodes 22 and water ( $H_2O$ ) is created. The power generating mechanism of the fuel cell 2 is achieved by going through such chemical reaction.

[0019] At the same time, the absorbents 52 become cooled and absorb the water as the heat exchange fluid at room temperature (for example approximately  $25^{\circ}C$ ) flows through the heat exchange part 51 of the absorption device 5. At this point, the heat exchange fluid becomes heated because the absorption heat generated from the abovementioned absorption is released into the heat exchange fluid that flows through the heat exchange part 51. That is to say, the outlet temperature  $T_2$  becomes higher than the inlet temperature  $T_1$  as shown in Fig. 3(a). Then, the heated heat exchange fluid is circulated to the heat exchange part 25 of the fuel cell 2 by going through the fluid circuit A and the heated heat exchange fluid releases its heat in the heat exchange part 25, thus heating the fuel cell 2.

[0020] Through this, right after the starting switch is turned on, that is to say, right after the fuel cell 2

begins generating power, the fuel cell 2 can be warmed up rapidly and the power generation efficiency of the fuel cell 2 can be improved rapidly. Therefore, electrical power can be supplied to the motor 7 for driving the vehicle right after the starting switch is turned on. Moreover, the heat exchange fluid that is supplied to the heat exchange part 51 of the absorption device 5 from the heat exchange part 25 of the fuel cell 2 can be cooled by using the abovementioned absorption heat for heating the fuel cell 2 and since the absorbents 52 of the absorption device 5 can be cooled, a good absorption of water by the absorption device 5 can be continued.

[0021] Further, after a predetermined time has elapsed since the starting switch is turned on, specifically, when the fuel cell 2 begins to generate power well, it will be switched to the abovementioned battery and power will be distributed to the electricity control device 200 by the fuel cell 2. At the same time, the abovementioned battery will begin to charge. Moreover, the pressure within the airtight containers 50 and 60 will be reduced as the abovementioned absorption begins and the evaporation of water in the condensation and evaporation device 6 accelerates. At this point, evaporative latent heat through the abovementioned evaporation is taken away from the heat

exchange fluid that flows through the heat exchange part 61 of the condensation and evaporation device 6. Therefore, this heat exchange fluid becomes cooled. By circulating this cooled heat exchange fluid to the outdoor heat exchange device 9 by going through the fluid circuit C, the cooled heat exchange fluid absorbs heat from the outdoors. Since the evaporative latent heat at the point of the water evaporation can be taken away from the outdoor air via the heat exchange fluid in this way, the evaporation of water can be done continuously.

[0022] Further, when hydrogen is released from the hydrogen absorbing alloys 32, since the released latent heat thereof is taken away from the surrounding area, the hydrogen absorbing alloys 32 are gradually cooled. However, when they are cooled too much as time elapses, hydrogen can no longer be released from the hydrogen absorbing alloys 32. Compared to this, the abovementioned released latent heat is taken away from the outdoor air through the outdoor heat exchange device 9. Therefore, a good release of hydrogen can continue.

[0023] Then, when the absorption by the absorption device 5 is performed, the heat exchange fluid that flows through the heat exchange part 51 of the absorption device 5 will have a higher outlet temperature  $T_2$  than an

inlet temperature T1 as mentioned above. However, when the absorption is completed, the inlet temperature T1 and the outlet temperature T2 will be about the same (time t1 in Fig. 3). Here, when the fuel cell 2 is in a steady state of power generation as the fuel cell 2 continues to generate power, the temperature of the fuel cell 2 will gradually increase as reaction heat is generated through the abovementioned chemical reaction (heat generation). Then, when the temperature becomes [a temperature] where water can be desorbed from the absorbents 52 after the absorption is completed (for example when it becomes 100° C), the fluid that was heated by the heat exchange part 25 of the fuel cell 2 releases heat by flowing through the heat exchange part 51 of the absorption device 5 that is in an absorption completion state. Through which, the absorption device 5 becomes heated and the absorption device 5 begins desorbing water.

[0024] As a result, the heat exchange fluid that flows through the heat exchange part 51 of the absorption device 5 is cooled by losing the desorption heat by desorbing water. Therefore, the inlet temperature T1 becomes higher than the outlet temperature T2. That is to say, the determination results of step S1 in Fig. 4 becomes

YES. Further, during this desorption, there is the effect that damage to

/5

the fuel cell 2 can be controlled by cooling the fuel cell 2 that is generating heat.

[0025] At the same time, condensation of the water begins at the condensation and evaporation device 6. The heat exchange part 61 of the condensation and evaporation device 6 heats the heat exchange fluid by releasing the heat, which is the part of the condensation heat from the condensation, to the heat exchange fluid that flows through the fluid circuit C. Then the heated heat exchange fluid is released to the outdoor air by circulating this heated heat exchange fluid to the outdoor heat exchange device 9. Through this, the condensation of the water can be done continuously.

[0026] Afterwards, the absorption device 5 is gradually converged into the desorption completion state and the time  $t_3$  in Fig. 3 becomes  $|T_2 - T_1| < \varepsilon$  ( $\varepsilon \neq 0$ , for example  $\varepsilon = 0.5^\circ \text{C}$ ) and  $d(T_2 - T_1)/dt > 0$ . That is to say, the determination results of step S2 and S3 in Fig. 4 become YES. At this point, control 2 in Fig. 4 will be conducted with the estimation that almost all the water was desorbed

from the absorbents 52 of the absorption device 5 (desorption completion state).

[0027] Here, even right after [the state] switches to the desorption state from the absorption state (time  $t_2$  in Fig. 3), it becomes  $|T_2 - T_1| < \varepsilon$ . However, in this case, the determination result of the step S3 becomes NO because it becomes  $d(T_2 - T_1)/dt < 0$ , as shown in Fig. 3(c). Therefore, the control 2 will not be conducted. Moreover,  $d(T_2 - T_1)/dt$  refers to the inclination of the graph shown in Fig. 3(b).

[0028] To be precise, the control 2 is when the connecting part 55 is closed with the opening and closing valve 43 and when the turning position of the three-way selector valves 41 and 42 are in the dotted line position in Fig. 1. Through this, the heat generated from the fuel cell 2 can be released to the outdoor air from the outdoor heat exchange device 8 via the heat exchange fluid that flows through the fluid circuit B. Thus, the temperature of the fuel cell 2 can be prevented from getting abnormally high and damages to the constituent materials of the fuel cell 2 can be controlled.

[0029] Further, [the state] after the absorptive medium is desorbed from the absorbents 52 in claim 3 and 4 also includes the state when some absorptive media remains in the absorbents 52. Moreover, the detecting means of

claim 6 comprises the electricity control device 200 that conducts the estimation of the thermal sensing devices 45 and 46 and the steps S1 to S3. The control device in claim 6 is made by the electricity control device 200 that switches the turning position of the opening and closing valve 55 based on the detected signals from this detecting means.

[0030] Then, since the connecting part 55 of the absorption device 5 and the condensation and evaporation device 6 is closed by the opening and closing valve 43 after almost all the water was desorbed from the absorbents 52, the desorption state of the absorbents 52 of the absorption device 5 can be maintained until the next power generation begins. Thus, by opening the connecting part 55 when the next power generation begins, good absorption of the absorptive medium in the absorption device 5 can be conducted and a good rapid warm-up of the fuel cell 2 can be conducted.

[0031] Moreover, since the rapid warm-up of the fuel cell 2 is conducted by using the absorption heat from the abovementioned absorption in the present embodiment, the electrical energy of the fuel cell 2 used when rapidly warming up the fuel cell 2 can be reduced compared to conventional technologies that use the heat of an electric

heater and such. Moreover, when the fuel cell 2 is in a steady state of power generation, the heat generated by the fuel cell 2 is used for the desorption of the absorptive medium in the absorption device 5. Therefore, the electrical energy of the fuel cell 2 used during this desorption can be reduced as well.

[0032] Moreover, when the absorptive medium is being desorbed from the absorbents 52, the fuel cell 2 is cooled by using the heat of the fuel cell 2 to heat the absorption device 5 and after the absorptive mediums are desorbed, the fuel cell 2 is cooled with the outdoor heat exchange device (cooling device) 8. As a result, when the fuel cell 2 is in a steady state of power generation, the temperature of the fuel cell 2 can be constantly prevented from becoming abnormally high and the fuel cell 2 can keep [a temperature] between 100 to 200° C, for example. Thus, damage to the fuel cell 2 can be controlled.

[0033] Further, when the starting switch is turned off, the power distribution to the abovementioned fuel pump 4, pumps 40 and 44, and the abovementioned air pump will stop. Further, the turning position of the valves 41, 42, and 43 will remain in [the position of] the control 2.

(The second embodiment) In the present embodiment, the configuration of the condensation and evaporation device 6,

the outdoor heat exchange device 9, the fuel tank 3, the fluid circuits C and D, and a part of the pump 44 of the abovementioned first embodiment are changed as shown in Fig. 5. Specifically, a first heat exchange part 311 and a second heat exchange part 312 is placed on the fuel tank 3 and hydrogen absorbing alloys 32 are placed around the first heat exchange part 311 and the second heat exchange part 312. Then, the first heat exchange part 311 and the heat exchange part 61 of the condensation and evaporation device 6 are connected in series through the fluid circuit G, the second heat exchange part 312 and the indoor heat exchange device 10 are connected in series through the fluid circuit E, and the second heat exchange part 312 and the outdoor heat exchange device 9 are connected in series through the fluid circuit F.

[0034] Further, a water pump 441 that circulates fluid to the fluid circuit G is placed on the fluid circuit G and a water pump 442 that circulates fluid to each fluid circuit E and F is placed on the location where the fluid circuit E and the fluid circuit F overlap. Moreover, heat exchange fluid is circulated to the fluid circuit E and the fluid circuit F with the three-way selector valves 47 and 48. Moreover, turning on and off of the power distribution to the water pumps 441 and 442 as well as switching the

turning position of the three-way selector valves 47 and 48 are controlled by the abovementioned electricity control device 200 (refer to Fig. 1).

[0035] In the present embodiment, the signals from the air-conditioning switching means that switches the air-conditioning in the vehicle on and off is inputted by the abovementioned electrical control device 200 (refer to Fig. 1). When the air-conditioning is on, the turning position of the three-way selector valves 47 and 48 is in the solid line position in Fig. 5 and when the air-conditioning is off, the turning position of the three-way selector valves 47 and 48 is in the dotted line position in Fig. 5.

[0036] Here, when hydrogen is released, the hydrogen absorbing alloys 32 take the released latent heat thereof from the surrounding. Thus, the heat exchange fluid that flows through the heat exchange part 312 that is placed within the hydrogen absorbing alloys 32

/6

is cooled and the interior is air-conditioned by circulating this fluid to the indoor heat exchange device 10. Then, the air-conditioning is turned on and right after the starting switch is turned on the heat exchange fluid that flows through the heat exchange part 61 of the condensation and evaporation device 6 is cooled with

the evaporative latent heat from the water evaporation in the condensation and evaporation device 6. The hydrogen absorbing alloys 32 can be cooled as this cooled heat exchange fluid is flowed to the first heat exchange part 311 by going through the fluid circuit G.

[0037] Therefore, the heat exchange fluid that flows through the second heat exchange part 312 can be rapidly cooled with the cooled heat of the hydrogen absorbing alloys 32 and with the abovementioned released latent heat. Thus, the interior air can be cooled rapidly with the indoor heat exchange device 10 that uses the cooled heat of this heat exchange fluids as its cold source. Moreover, by using the abovementioned evaporative latent heat as mentioned above, a good evaporation of the water can be conducted continuously.

[0038] Moreover, when the water condenses in the condensation and evaporation device 6, the condensation heat thereof will be released to the hydrogen absorbing alloys 32 via the heat exchange fluid that flows through the fluid circuit G. Thus, 1) a good condensation of the water can be continued and 2) supercooling of the hydrogen absorbing alloys 32 can be controlled and a good release of hydrogen can be continued. Then, when the determination

result of the abovementioned steps S1 to S3 become YES, the power distribution to the pump 441 will stop.

[0039] Further, the description of the controls pertaining to the absorption device 5 or the hydrogen battery 2 and such will be omitted since they are the same as the first embodiment.

(Other embodiments) In the abovementioned second embodiment, the fluid was circulated between the heat exchange part 61 of the condensation and evaporation device 6 and the fluid passageway 312 of the fuel tank 3. However, the fluid may be circulated between the heat exchange part 61 of the condensation and evaporation device 6 and the indoor heat exchange device 10. In this case, when the determination result of the abovementioned step S1 is YES, that is to say, when desorption begins, it would be best to stop the circulation of the fluid between the heat exchange part 61 of the condensation and evaporation device 6 and the indoor heat exchange device 10.

[0040] Moreover, in the present embodiment, the fluid temperatures T1 and T2 that flow through the inlet and outlet of the heat exchange part 51 of the absorption device 5 and the electricity control device 200 that determines the abovementioned steps S1 to S3 were part of the detecting means in claim 6. However, this is not

limited to this, and the water absorption and desorption in the absorption device 5 may be detected with other various detecting means.

[0041] Moreover, the control 2 was performed when the detection results of the abovementioned steps S1 to S3 are YES. However, it is not limited to this and the control 2 may be performed after it was detected with other various methods that the desorption of the absorbents 52 of the absorption device 5 was completed.

[Brief description of the figures]

[Fig. 1] A schematic drawing of the general structure of the fuel-cell-powered vehicle pertaining to the first embodiment of the present invention.

[Fig. 2] A schematic perspective view of the fuel cell pertaining to the first embodiment.

[Fig. 3] (a) is a graph showing the changes in the inlet temperature  $T_1$  and the outlet temperature  $T_2$  of the heat exchange part of the absorption device vis-à-vis the time  $t$ , (b) is a graph showing the changes of  $(T_2 - T_1)$  vis-à-vis the time  $t$ , and (c) is a graph showing the changes of  $d(T_2 - T_1)/dt$  vis-à-vis the time  $t$ .

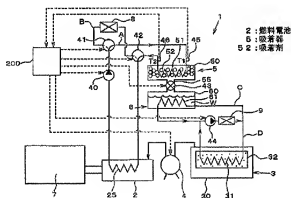
[Fig. 4] A flowchart showing the operations pertaining to the first embodiment.

[Fig. 5] A schematic drawing of the partial structure of the fuel-cell-powered vehicle pertaining to the second embodiment.

[Description of the enumerations]

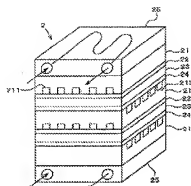
- 2 fuel cell
- 5 absorption device
- 52 absorbents

[Fig. 1]



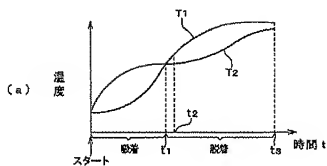
- 2: fuel cell
- 5: absorption device
- 52: absorbents

[Fig. 2]

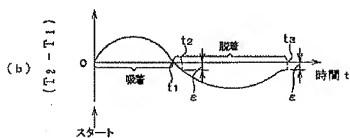


/7

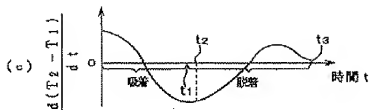
[Fig. 3]



[from the left] temperature, start, absorption,  
desorption, time t

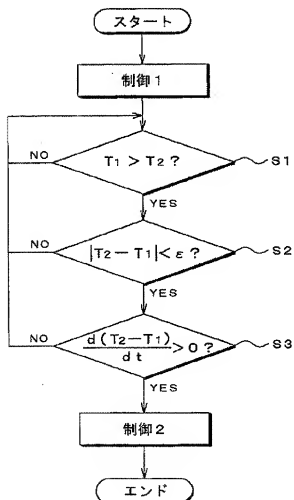


[from the left] start, absorption, desorption, time t



[from the left] absorption, desorption, time  $t$

[Fig. 4]



[from the top] start, control 1, control 2, end

[Fig. 5]

